

Using a Market Value Concept to Facilitate Negotiation of Alternative Price Formulas

**6 December 2006
Kaoru Kawamoto
Osaka Gas Co., Ltd**

Table of Contents

1. Background

2. Definition and Methodology

- Defining the market value of LNG price formula
- Methodology of evaluating its market value

3. Example of Evaluation

- S-curve formula indexed to crude oil price
- Linear formula indexed to natural gas price

Table of Contents

1. Background

2. Definition and Methodology

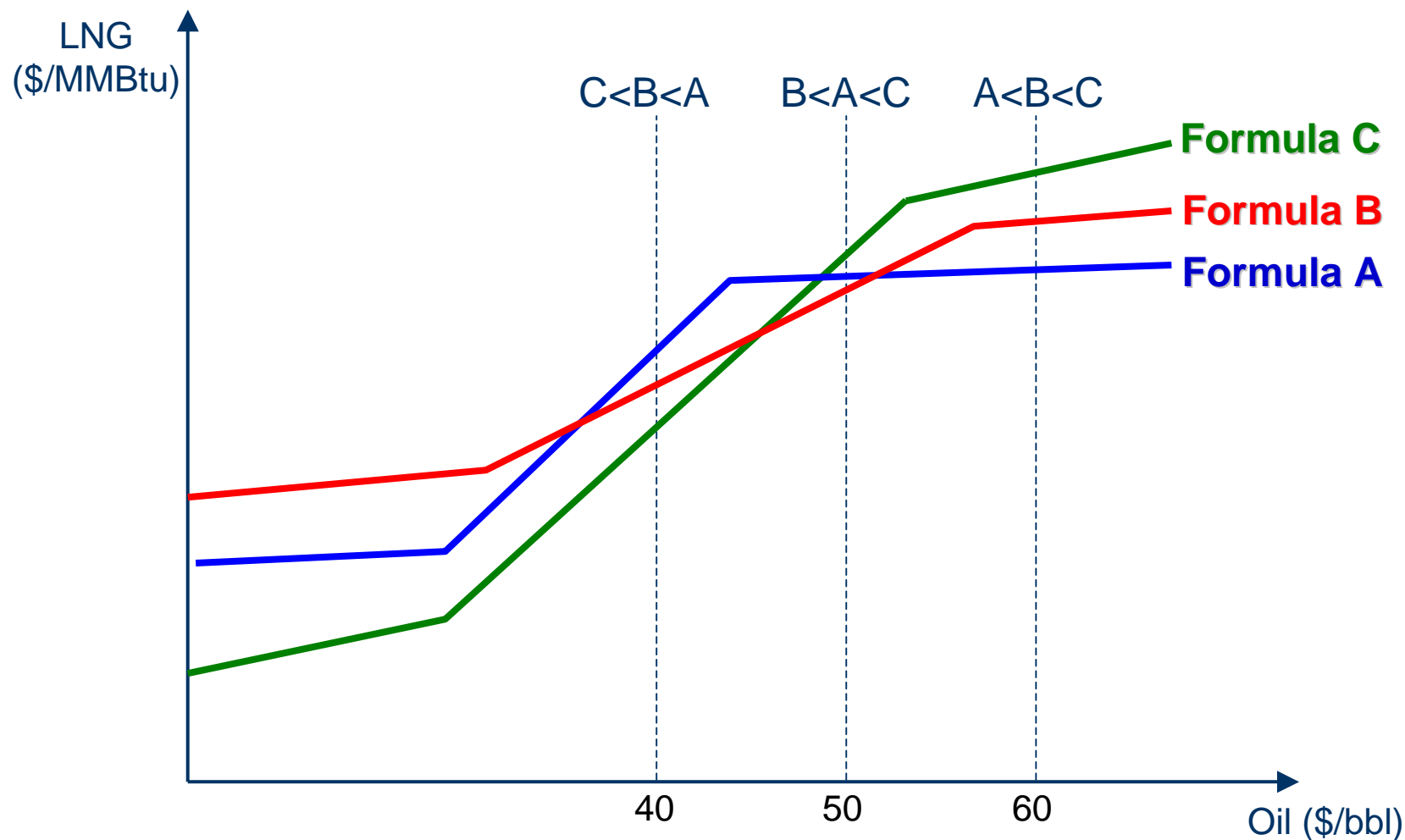
- Defining the market value of LNG price formula
- Methodology of evaluating its market value

3. Example of Evaluation

- S-curve formula indexed to crude oil price
- Linear formula indexed to natural gas price

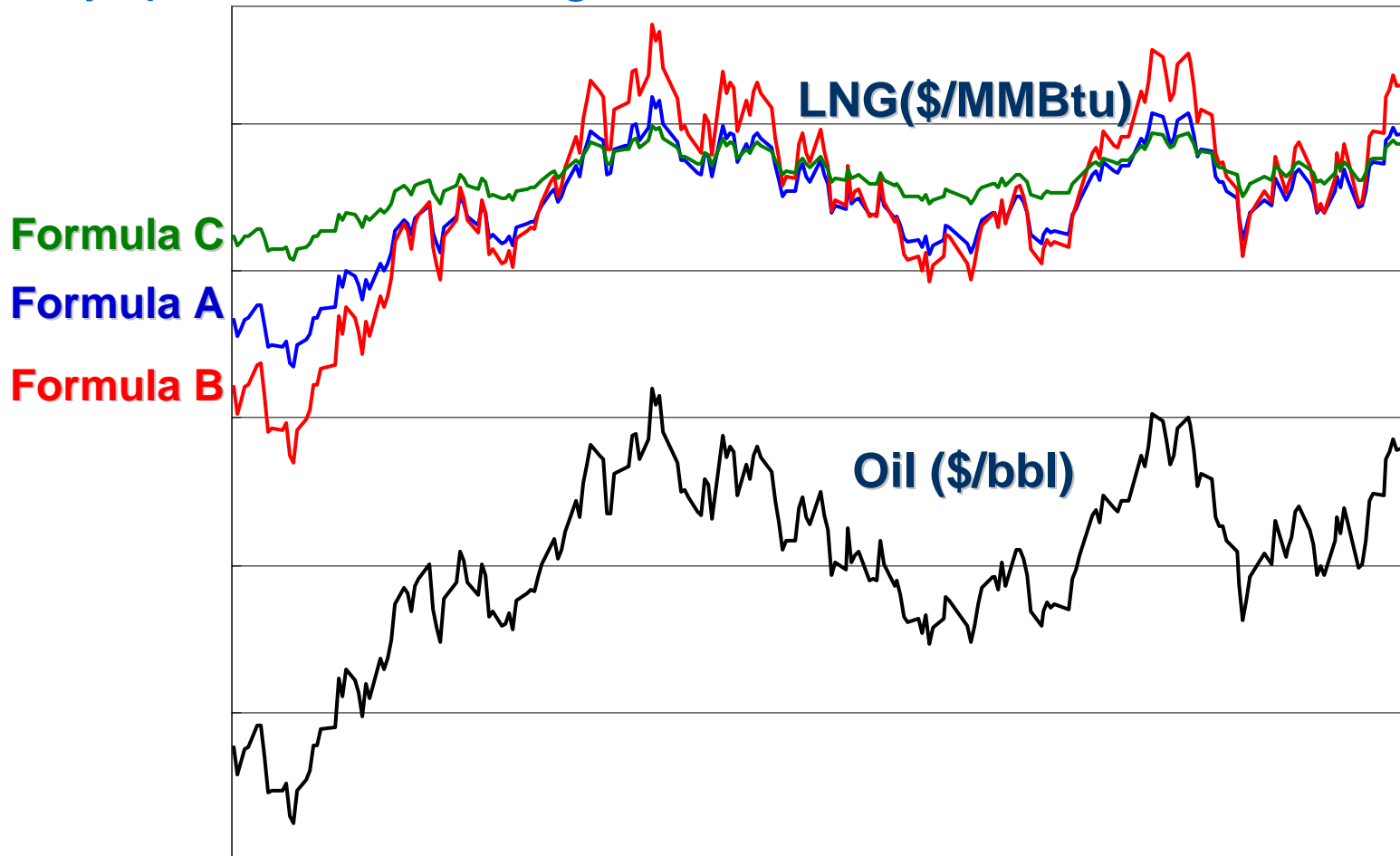
Variation of S-curve formulas

Relative level among different formulas varies along crude oil price.



Level of price formula varies along fluctuating oil price

It difficult to negotiate on an expected crude oil price.
As a result, sellers and buyers press their own subjective arguments.
Finally, price formula negotiation often becomes deadlocked.



Goal of this study : Develop a methodology for evaluating market value of LNG price formula

Objective and quantitative methodology to compare different formulas would make it easier to agree between sellers and buyers.



Formula C **Formula B** **Formula A**

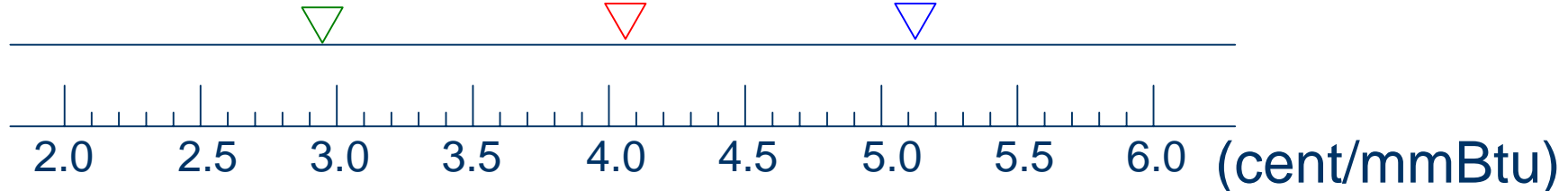


Table of Contents

1. Background

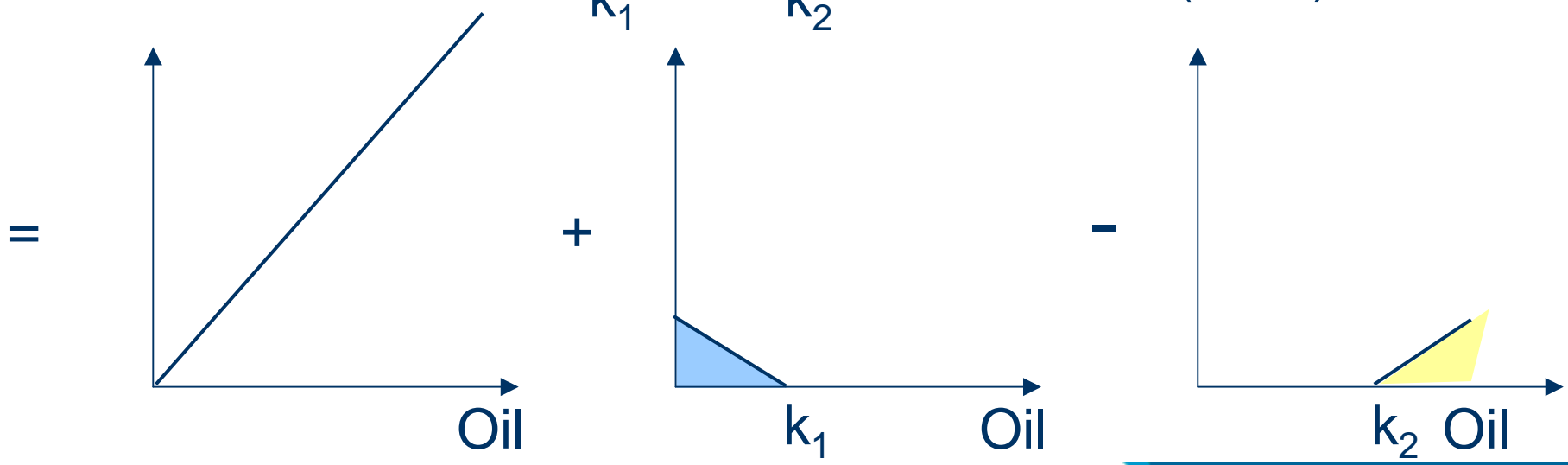
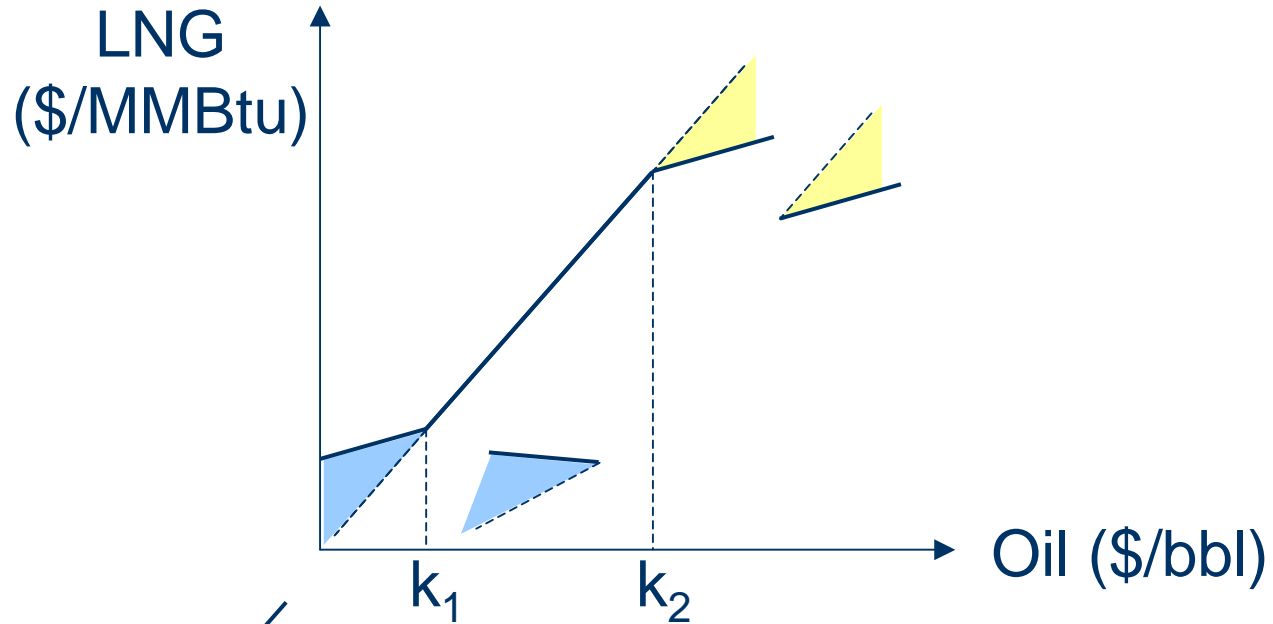
2. Definition and Methodology

- Defining the market value of LNG price formula
- Methodology of evaluating its market value

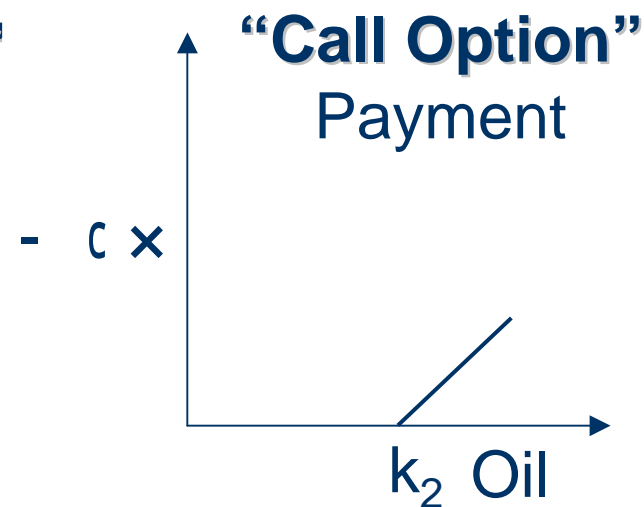
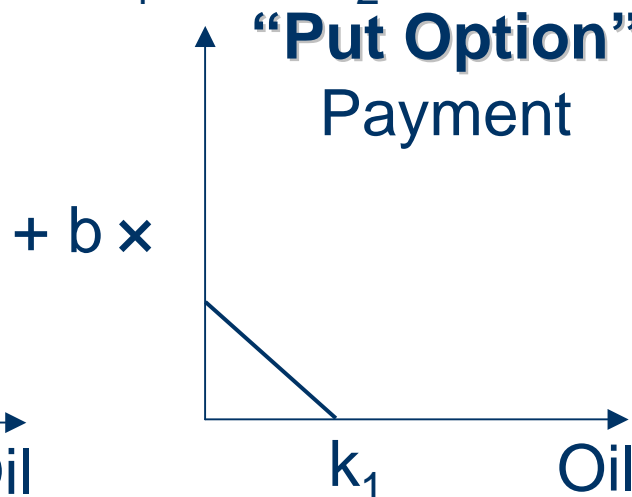
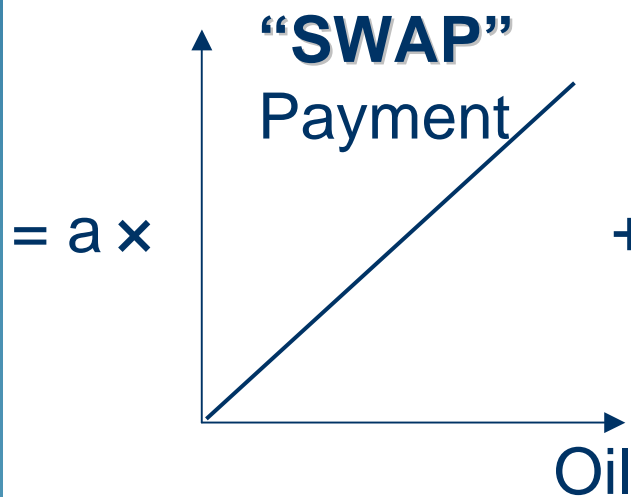
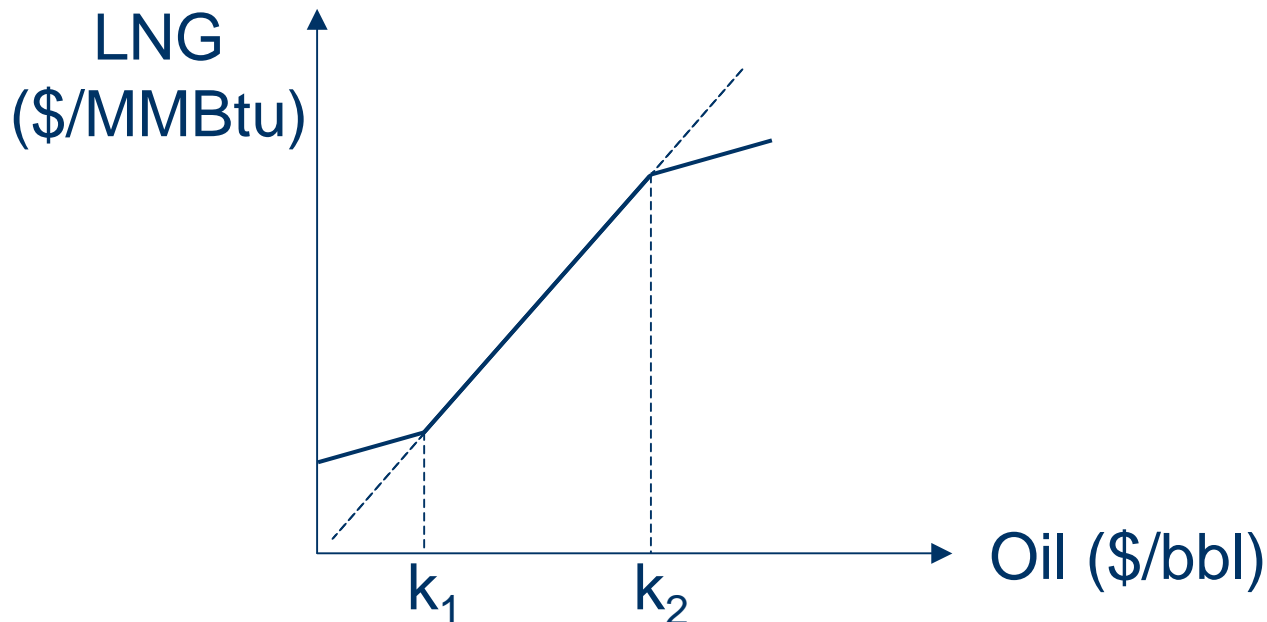
3. Example of Evaluation

- S-curve formula indexed to crude oil price
- Linear formula indexed to natural gas price

S-curve formula can be decomposed into oil derivative



S-curve formula can be decomposed into oil derivative



Defining the market value of LNG price formula

Market value of LNG price formula can be defined as the market value of crude oil derivatives replicating the formula. (A linear combination of SWAP, Call Option, and Put Option.)

Market value of S-curve formula for 3yrs

$$\begin{aligned} &:= a \times \text{"Oil SWAP" for 3yrs} \\ &+ b \times \text{"Oil Call Option" for 3yrs} \\ &+ c \times \text{"Oil Put Option" for 3yrs} \end{aligned}$$

Liquidity in crude oil derivative market

Market price of “Futures” and “Option” can be quoted from NYMEX. However, the liquidity in long maturity “Option” market is not enough.



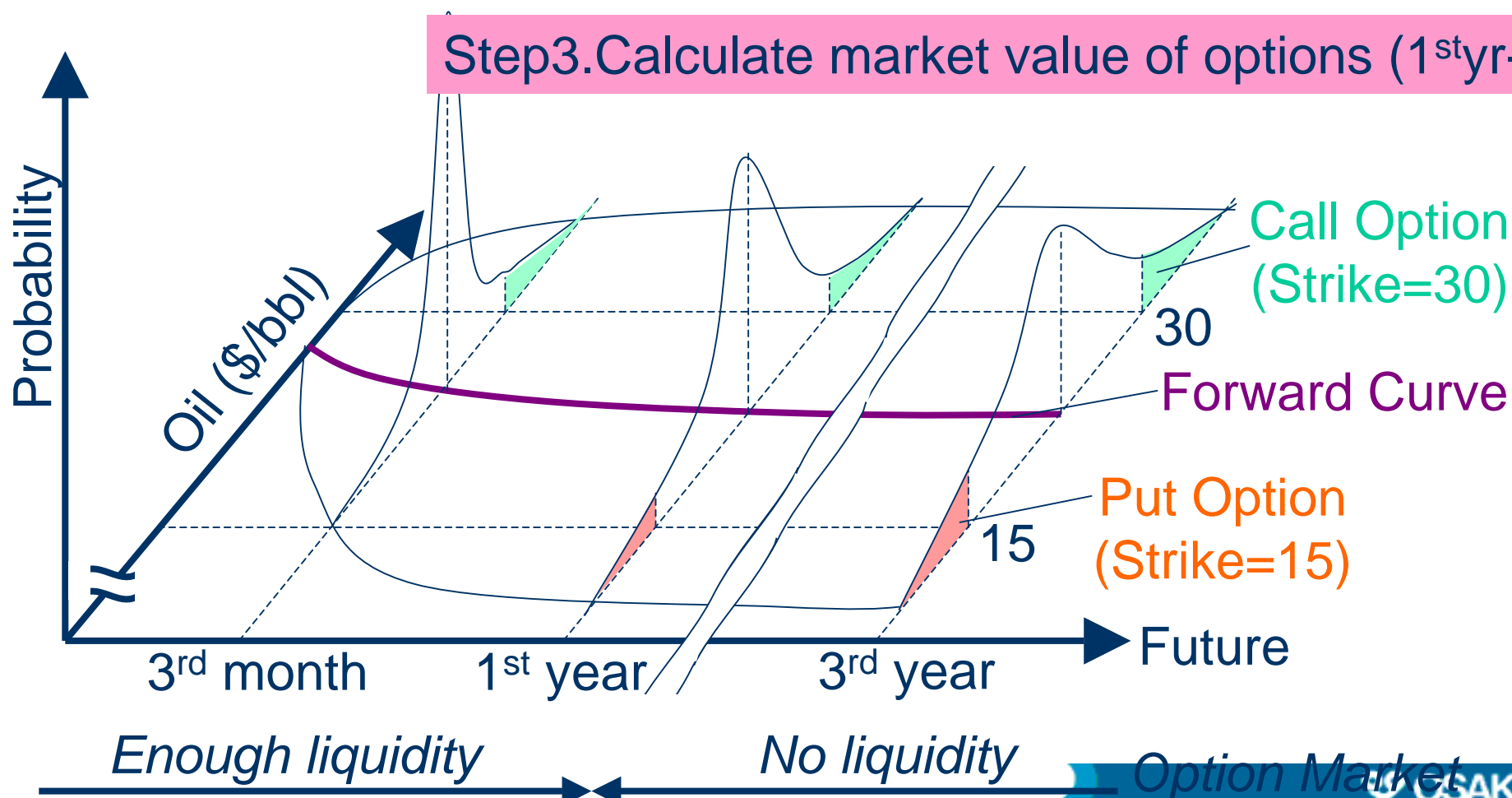
	Future (SWAP)	Call Option	Put Option
1 st yr			
2 nd yr		x	x
3 rd yr		x	x
4 th yr		x	x
5 th yr		x	x
6 th yr		x	x
7 th yr		x	x
8 th yr	x	x	x
⋮	⋮	⋮	⋮

Methodology of evaluating option prices

Step1. Adjust parameter for price model $ds / S = [\mu(t) - \alpha \ln S_t] dt + \sigma dz(t)$

Step2. Generate probability distribution of future prices

Step3. Calculate market value of options (1styr-)



Procedure of Evaluating Market Value of price formulas

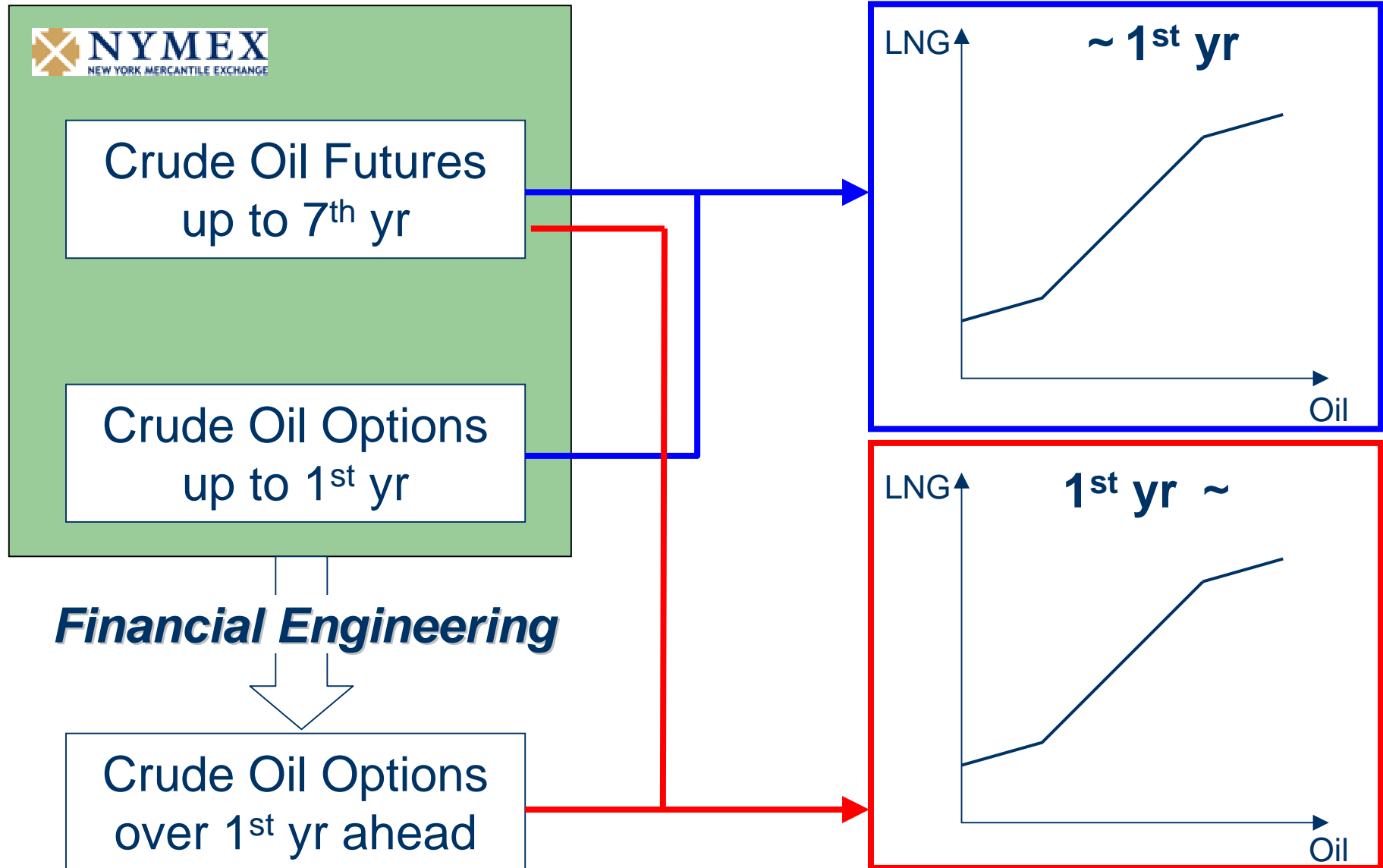


Table of Contents

1. Background

2. Definition and Methodology

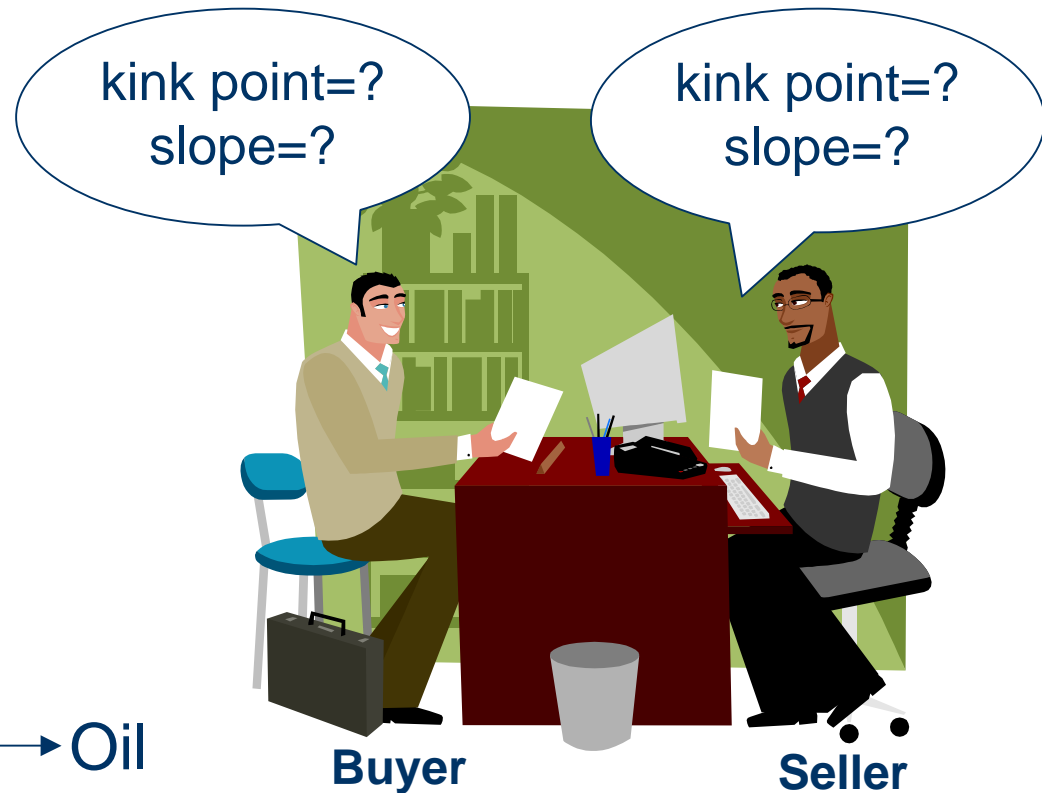
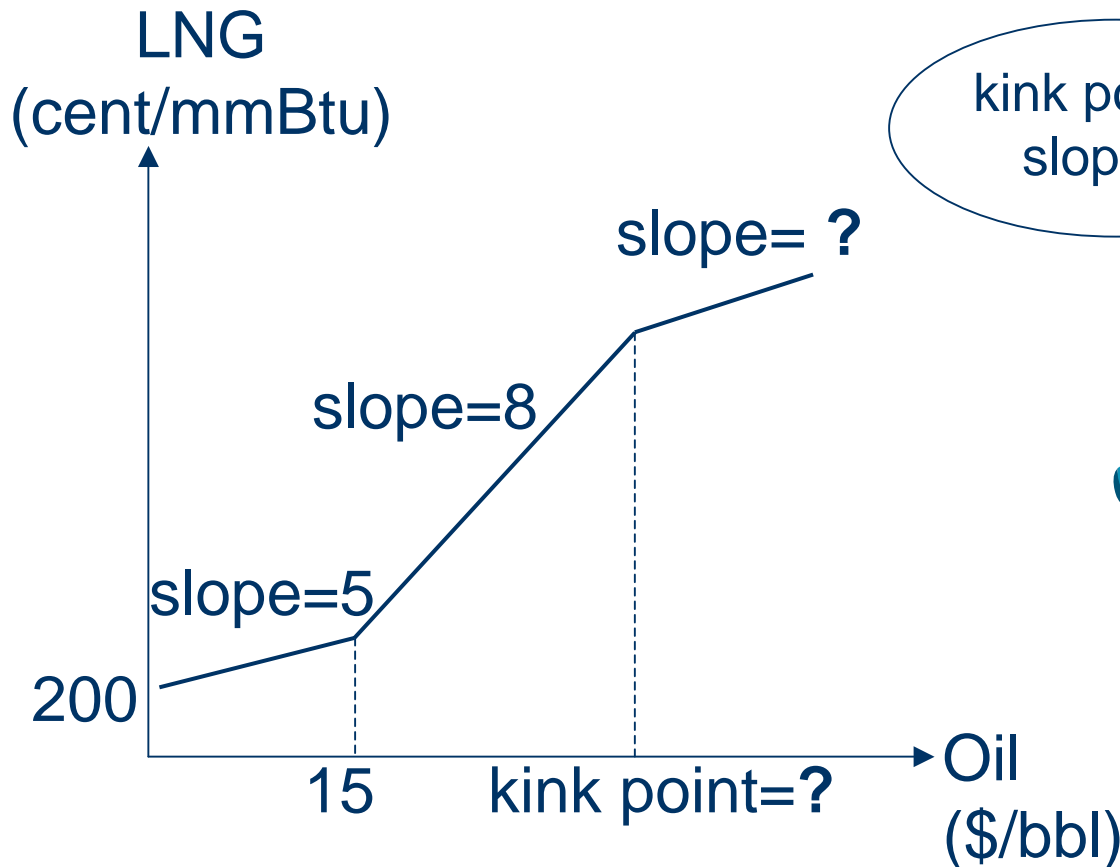
- Defining the market value of LNG price formula
- Methodology of evaluating its market value

3. Example of Evaluation

- S-curve formula indexed to crude oil price
- Linear formula indexed to natural gas price

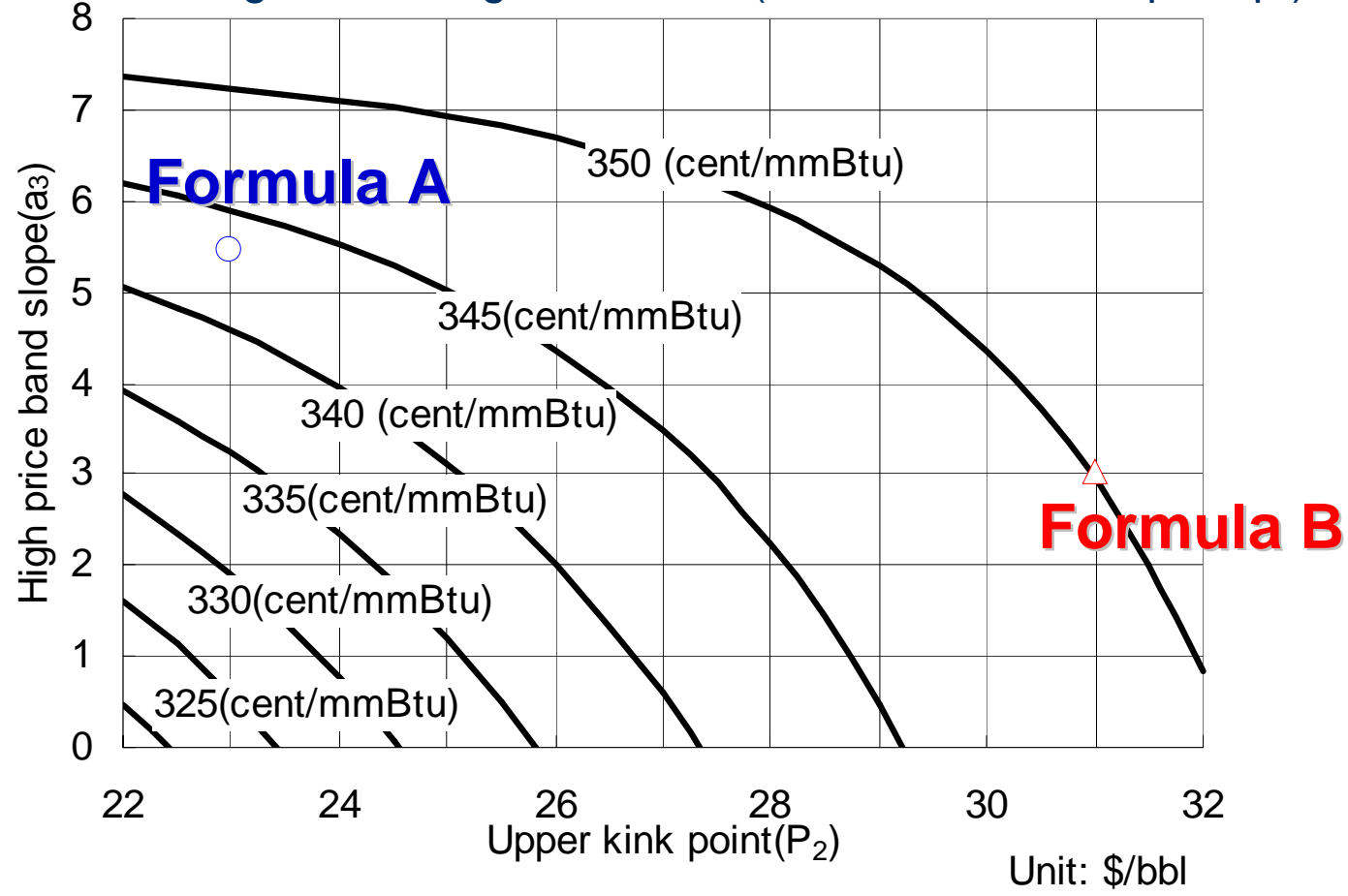
Examples of evaluating market value of S-curve formula

*Sellers and buyers are discussing
“upper kink point” and “high price band slope”*



Drawing equivalent line chart from results

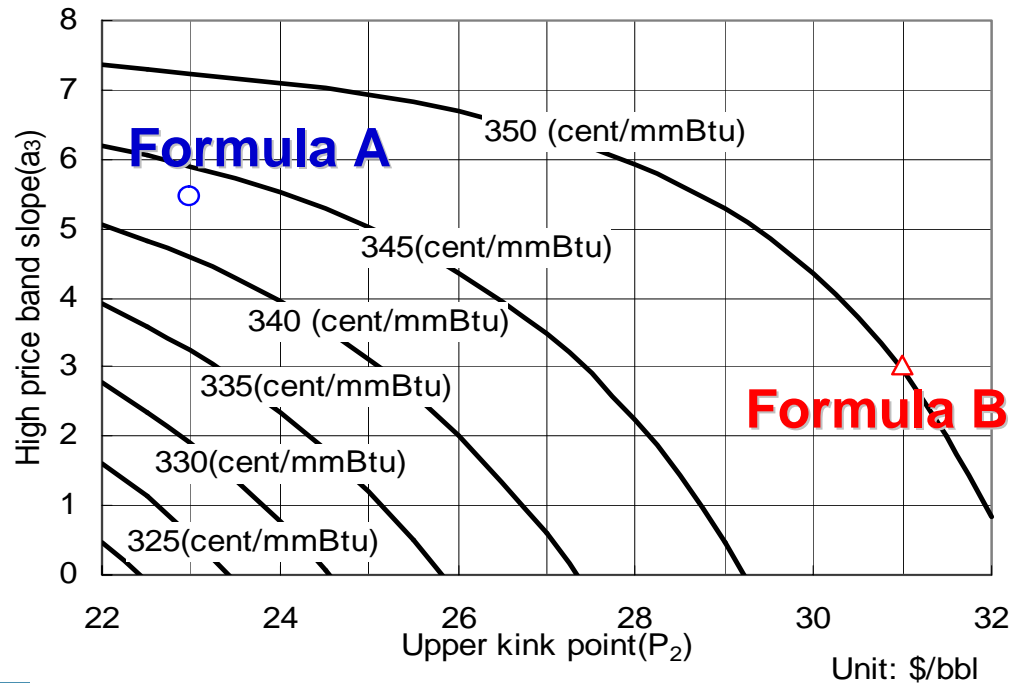
Evaluating date = August 1, 2003 (WTI = 32 \$/bbl at prompt)



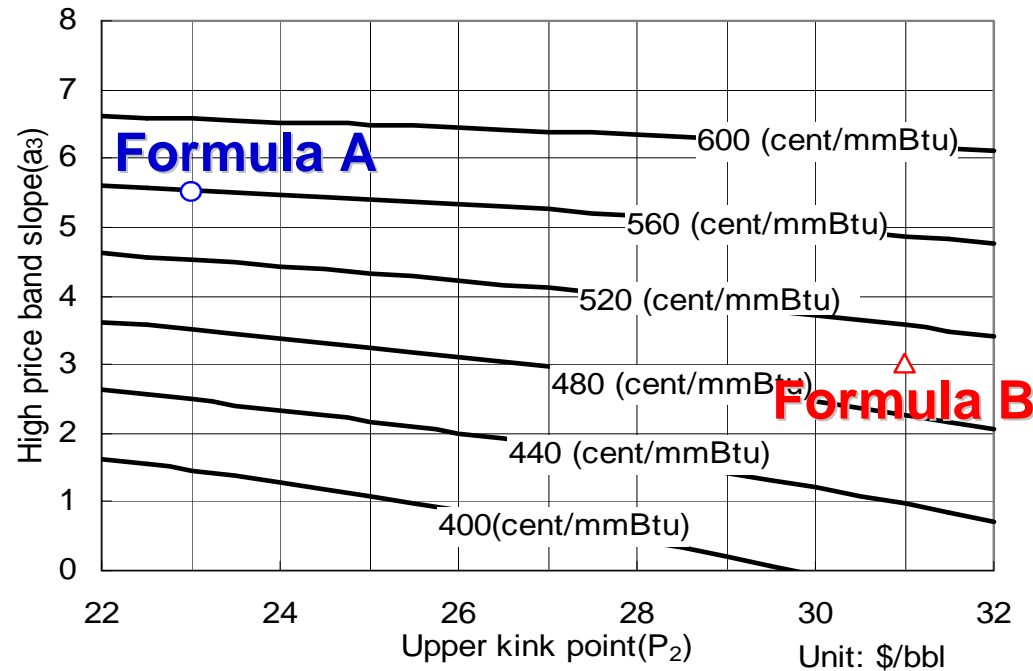
Formula A > Formula B
Formula C = Formula B

Market value differs among evaluating dates

Evaluating date = August 1, 2003
(WTI = 32 \$/bbl at prompt)



Evaluating date = September 27, 2006
(WTI = 63 \$/bbl at prompt)



Formula A < Formula B on Aug 1st 2003

Formula A > Formula B on Sep 27th 2006

Application to linear formula indexed to natural gas

Sellers and buyers are discussing “slope” and “constant”

LNG
(cent/mmBtu)

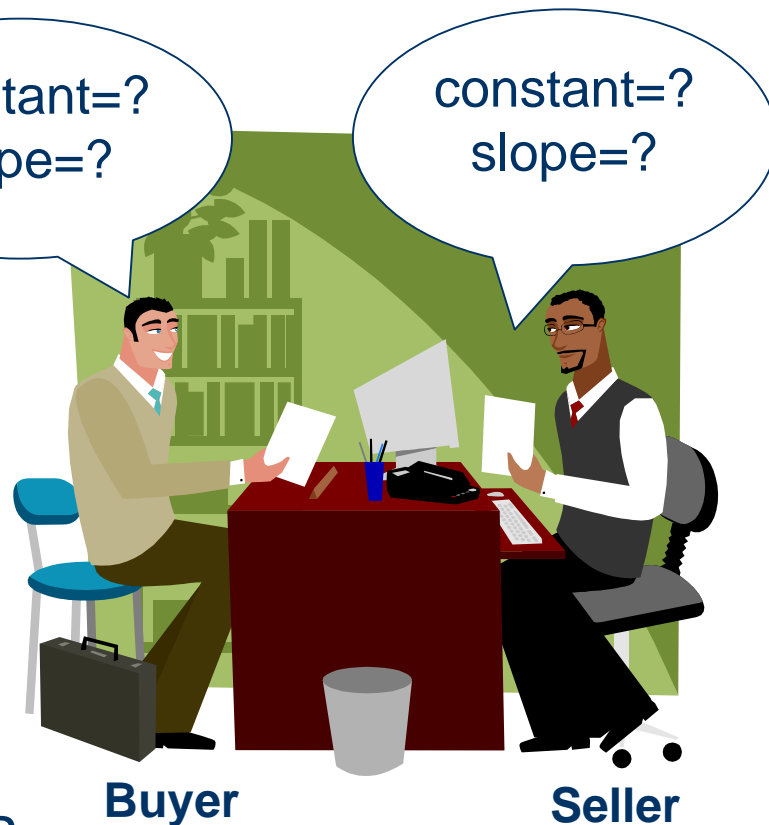
slope = ?

Constant = ?

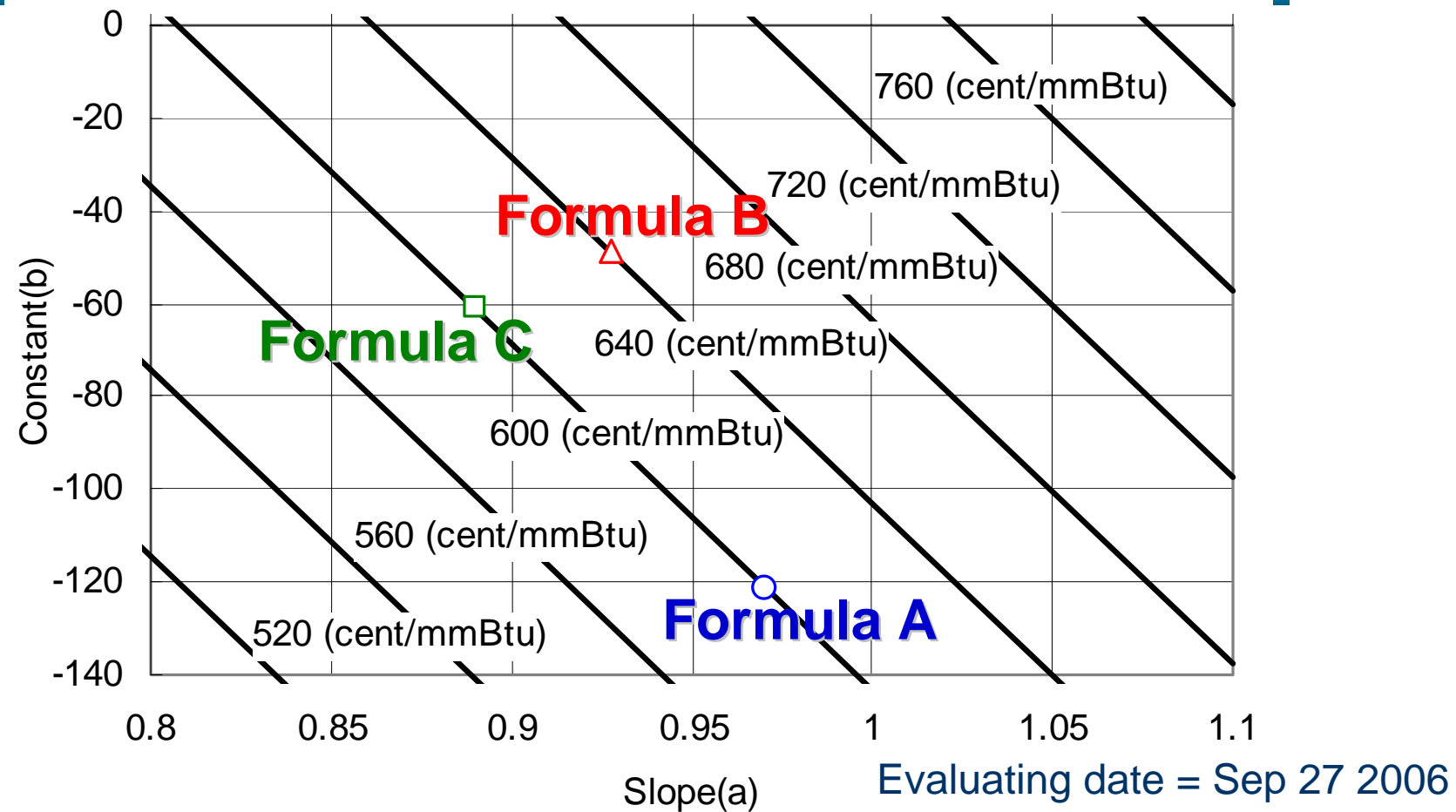
Natural Gas
(cent/mmBtu)

constant = ?
slope = ?

constant = ?
slope = ?



Drawing equivalent line chart from results

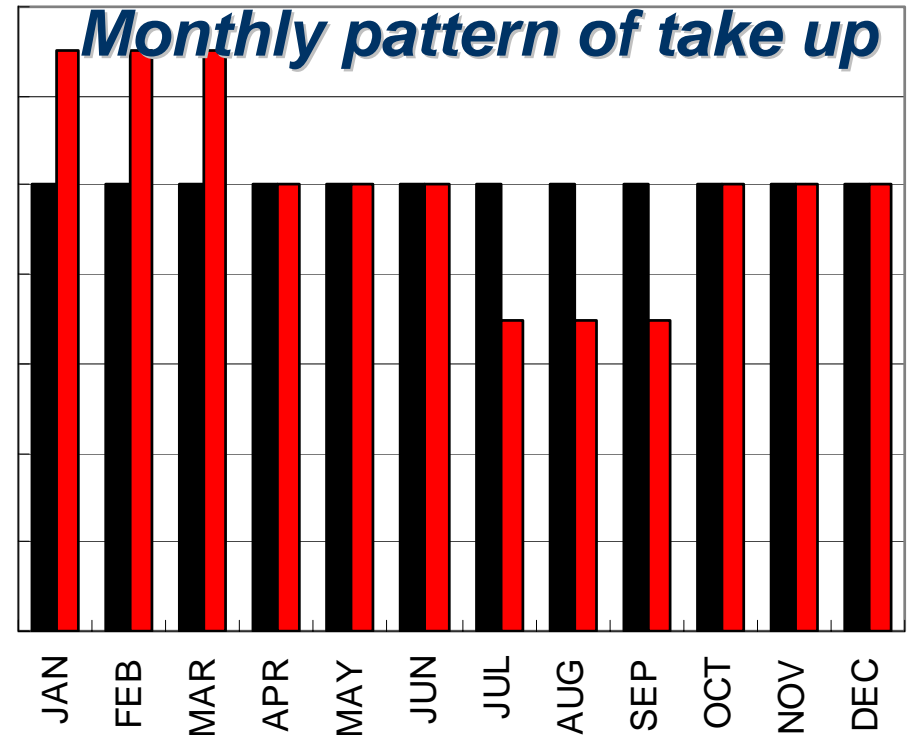
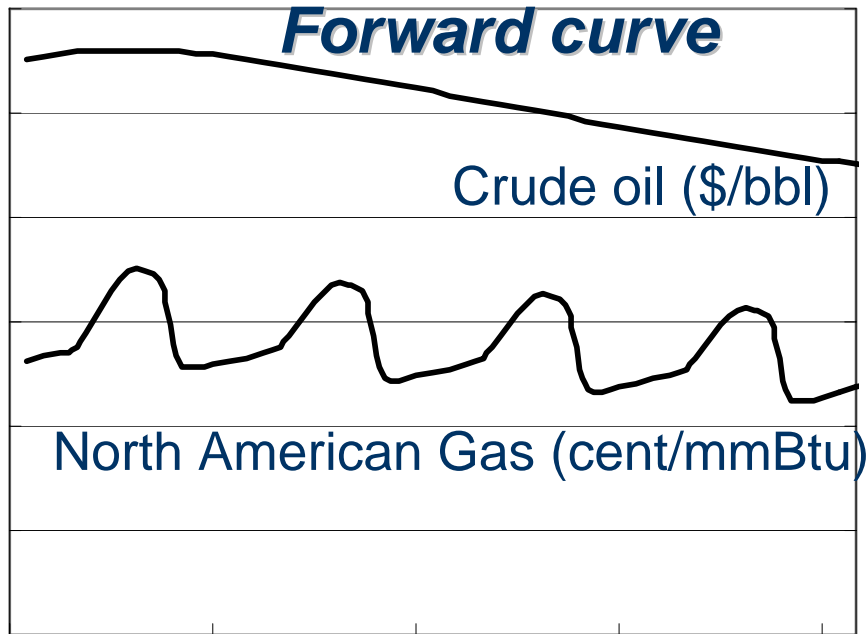


Formula B > Formula A

Formula C = Formula A

Seasonality of take-up pattern affects market value of LNG price formula indexed to natural gas

Natural gas price has seasonal variation (It is higher in winter). As a result, LNG procurement costs priced by natural gas indexed formulas are affected by the seasonal variation of take-up.



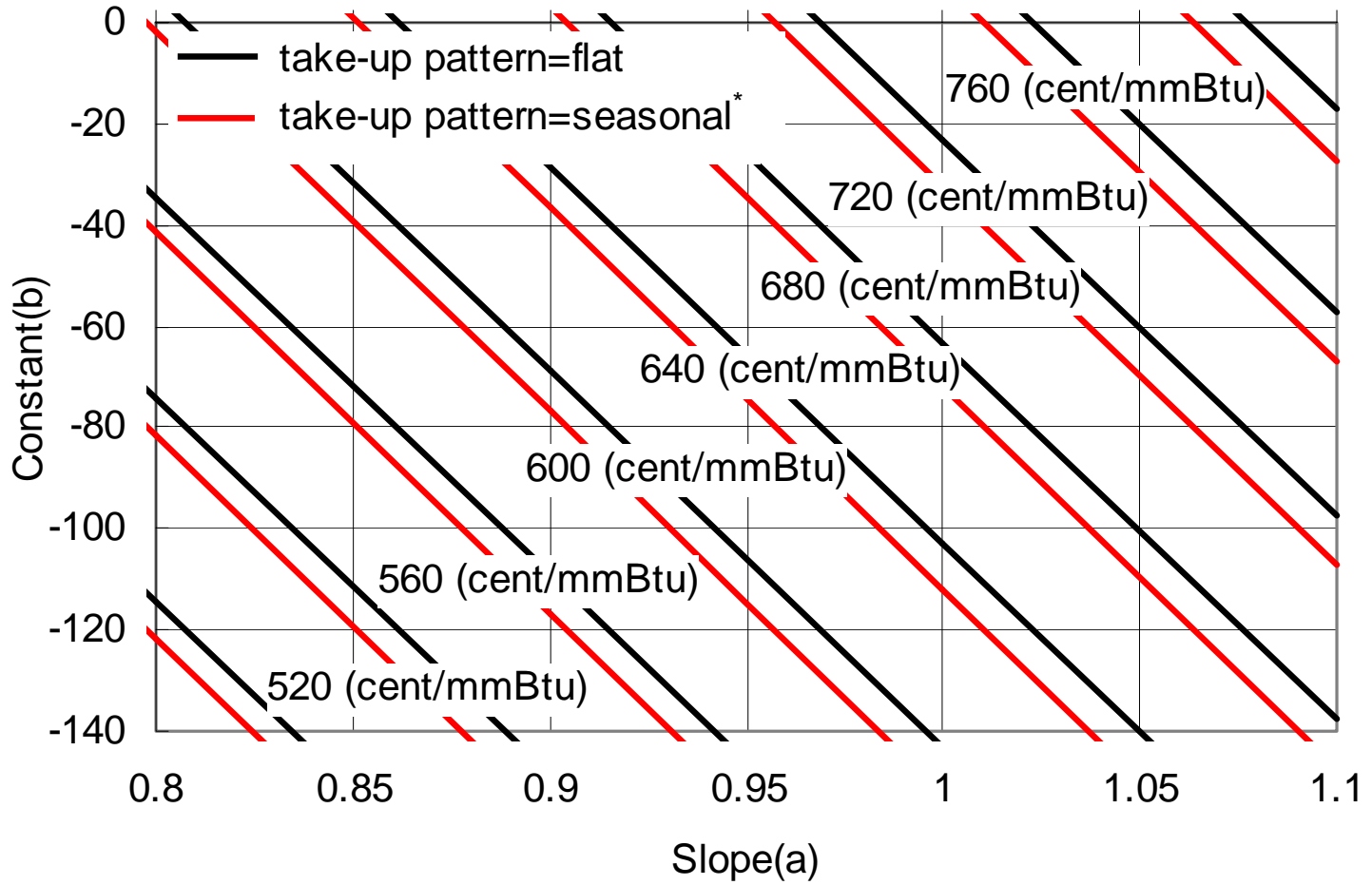
$$\sum_{t=1}^T (\text{Black Bar} \times \text{Gas Price}) < \sum_{t=1}^T (\text{Red Bar} \times \text{Gas Price})$$

Equivalent line chart varies along the take-up pattern

Case1. Take-up pattern = flat

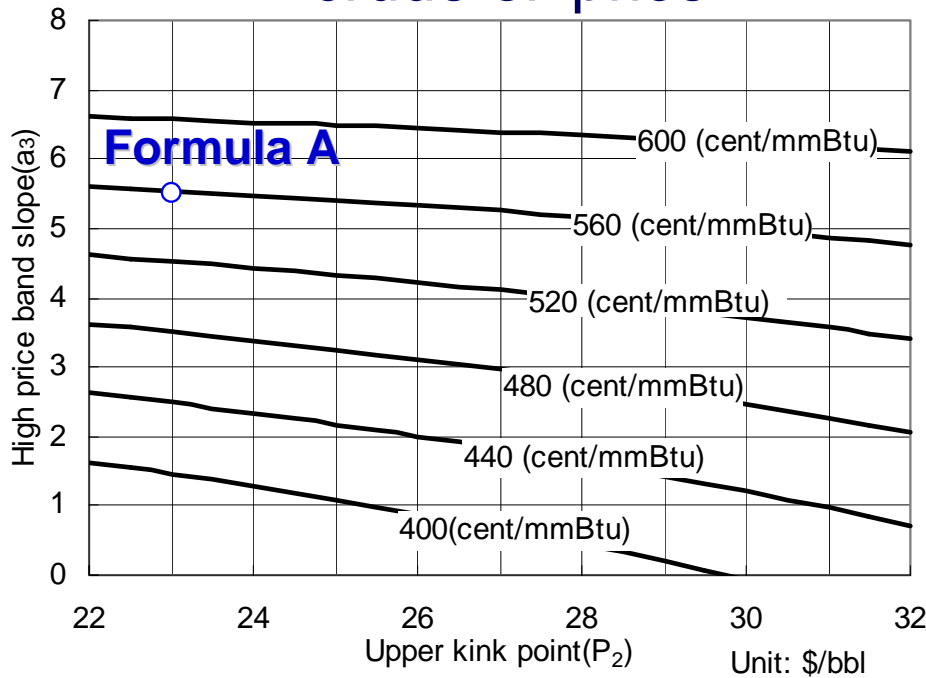
Case2. Take-up pattern = seasonal

(30% higher in winter and 30% lower in summer than intermediate months)



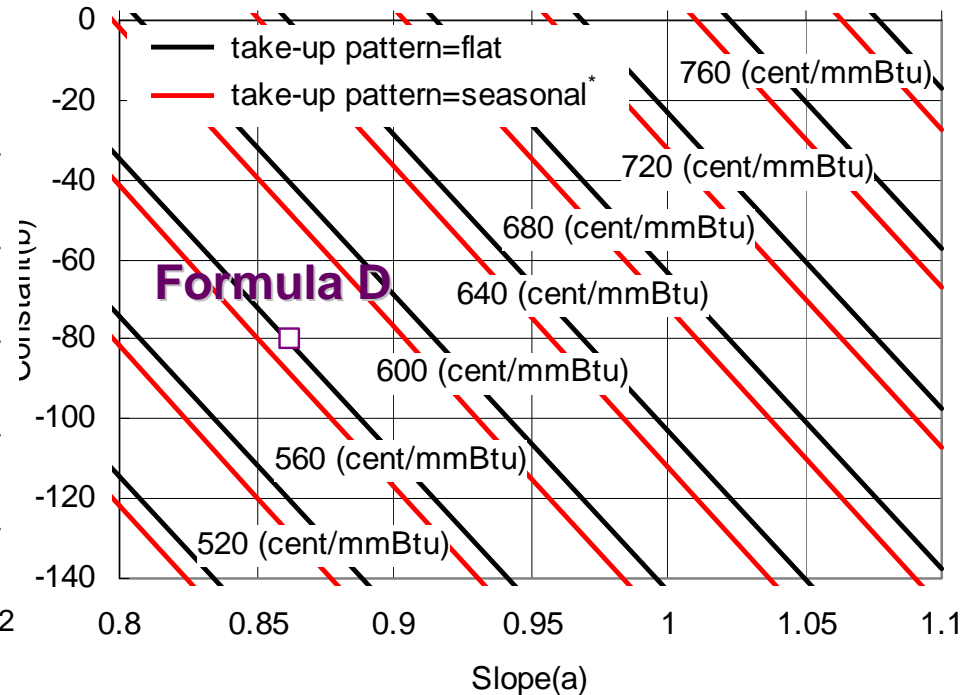
Comparing market value of LNG price formulas with different shapes or different indices

S-curve formula indexed to crude oil price



Evaluating date = Sep 27 2006

Linear formula indexed to North American Gas



Evaluating date = Sep 27 2006

Formula A = Formula D (take-up pattern is flat)

Formula A < Formula D (take-up pattern is seasonal)

Conclusions

1. We have established a methodology of evaluating “market value of LNG price formulas” by breaking down it into crude oil derivatives.
2. This methodology makes it possible to compare different price formulas (different indices or forms), for example, S-curve formula indexed to oil price, linear formula indexed to oil price, and linear formula indexed to natural gas price. It is also possible to find formulas which are equivalent but have different indices or forms.
3. This methodology is for comparative evaluation of different price formulas, not for judgment on the appropriateness of the market value level for a price formula.
4. Next step is to establish a methodology of evaluating “market value of LNG contract clauses other than price, such as flexibility in take-up quantity. Finally, we would like to establish all-encompassing market value evaluation for LNG contracts.